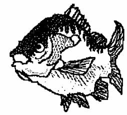


Study conducted by:

COMMONWEALTH BIOMONITORING
8061 Windham Lake Drive
Indianapolis, IN 46214
317-297-7713



# *JIMMERSON LAKE DIAGNOSTIC STUDY*

**A Lake and River Enhancement Project funded by the Indiana Department of Natural Resources Division of Soil Conservation Indianapolis IN**

**For the Jimmerson Lake Association Angola, Indiana**

**Submitted: January 2003**

Table of Contents

Table of Contents (Continued)

# EXECUTIVE SUMMARY

The Jimmerson Lake Association received a grant from the Indiana Department of Natural Resources Division of Soil Conservation through the Indiana Lake and River Enhancement Program. The purpose of the grant was to assist the association conduct a "Preliminary Diagnostic Study" for documenting water quality and identifying potential problems in Jimmerson Lake in Steuben County, Indiana.

First, all available information on the lake was assembled. Copies of many previous studies are included in the Appendix. Examples of available information include water quality measurements by various state, federal, academic, and volunteer groups. Recent fisheries studies have also been completed. Jimmerson Lake has a wealth of wetlands and associated aquatic species not found in most other areas of Indiana. It also has a healthy fish community. Nutrient levels are low and water clarity is relatively high as compared to most other Indiana lakes. Pathogenic bacteria levels have not been a problem.

Next, new information was gathered on lake water budgets, watershed land use, soil types, stormwater management practices, number of residents, wetland quality, water and sediment nutrient values, wastewater treatment, and boat use. The new information was used to identify potential problems in the lake and work toward economical solutions.

Among the potential lake management problems and potential solutions identified in this "diagnostic" study were:

There is a high percentage of soils on steep slopes immediately surrounding the lake. These areas are highly vulnerable to erosion whenever vegetation is disturbed. Excess erosion could contribute to sediment and nutrient loading to the lake. These areas should be managed especially carefully.

Stormwater runoff from the Buena Vista area on the north side of the lake has especially high concentrations of nutrients and sediment. Reducing storm-related loading from this area is desirable.

The number of boats using the lake is extremely high compared to most other Indiana lakes. High speed boats often contribute to disruption of valuable emergent vegetation beds in shallow areas.

Although not yet prolific enough to create a problem, concrete seawalls on lakefront property should be discouraged. They contribute to shoreline erosion and loss of aquatic plant and animal diversity throughout the lake.

Jimmerson Lake has an unusually high number of rare biological resources, most of which are associated with the wetlands and forested areas near the lake. It may be necessary for the lake association to buy these properties and manage them for conservation purposes

Over 90% of the watershed area upstream from the lake has not had any type of land use planning. It would be useful for all lakes upstream from Jimmerson to have some type of lake management plan to keep the entire watershed healthy.

Computer modeling done as part of this project showed the types of changes that would be expected to occur with various changes in land use or management. For example, one model predicted that a 50% decrease in nutrient loading would result in a gradual but lowering of the water column nutrient values. This chemical change would be associated with a decrease in algae concentrations and an increase in game fish populations within one year. A second computer model predicts that the recent sewer project around the lake will decrease phosphorus loading to the lake and result in an additional foot of water clarity.

A public meeting was also held as part of the project on December 14, 2002. The meeting explained the findings of the study, both in an oral presentation session and through the distribution of a project brochure.

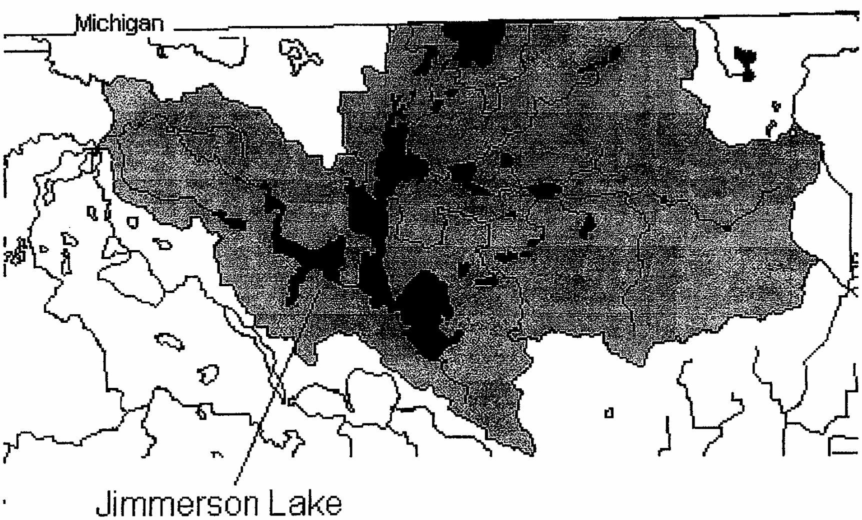
# JIMMERSON LAKE DIAGNOSTIC STUDY

## I. INTRODUCTION

### A. BACKGROUND OF THE STUDY

Jimmerson Lake in northern Steuben County has a surface area of 346 acres and a drainage area of 52 square miles in the Fawn River watershed of northern Indiana. The primary drainage inlet is from Lake James (48 square miles), although there are several tile inlets around the lake as well. To protect and enhance the quality of the lake. the Jimmerson Lake Association received funding from the Indiana Lake and River Enhancement program of IDNR in August 2002. The purpose of the grant was to conduct a "Preliminary Diagnostic Study" of the lake. This type of study is designed to collect information that a lake association can use to effectively manage the lake's resources.

Figure 1. Jimmerson Lake and the Lake James Chain



### B. STEPS IN A DIAGNOSTIC PLAN

1. Compile historical data on the lakes
2. Map and describe watershed conditions
3. Compile and analyze available water quality, biological and habitat conditions in the lake
4. Prepare a water budget
5. Map the shoreline
6. Analyze sedimentation
7. Aquatic plant and nuisance species survey
8. Analyze trends
9. Model nonpoint source pollution in the lake and watershed
10. Prioritize management recommendations
11. Create a public information handout
12. Facilitate a public meeting
13. Issue monthly progress reports
14. Complete a lake diagnostic study report

## II. IDENTIFYING CRITICAL INFORMATION

### A. WHAT DO WE ALREADY KNOW ABOUT THE LAKE?

USGS, 1980. Drainage atlas of Indiana.

Jimmerson Lake is fed mainly by the outlet of Lake James, which has a total drainage area of 48 square miles. Other lakes in the watershed upstream from Jimmerson and James include Lake George and Marsh, Big and Little Otter, Snow Lakes.

Indiana Lake Classification System and Management Plan, 1986. Indiana Department of Environmental Management, Indianapolis IN.

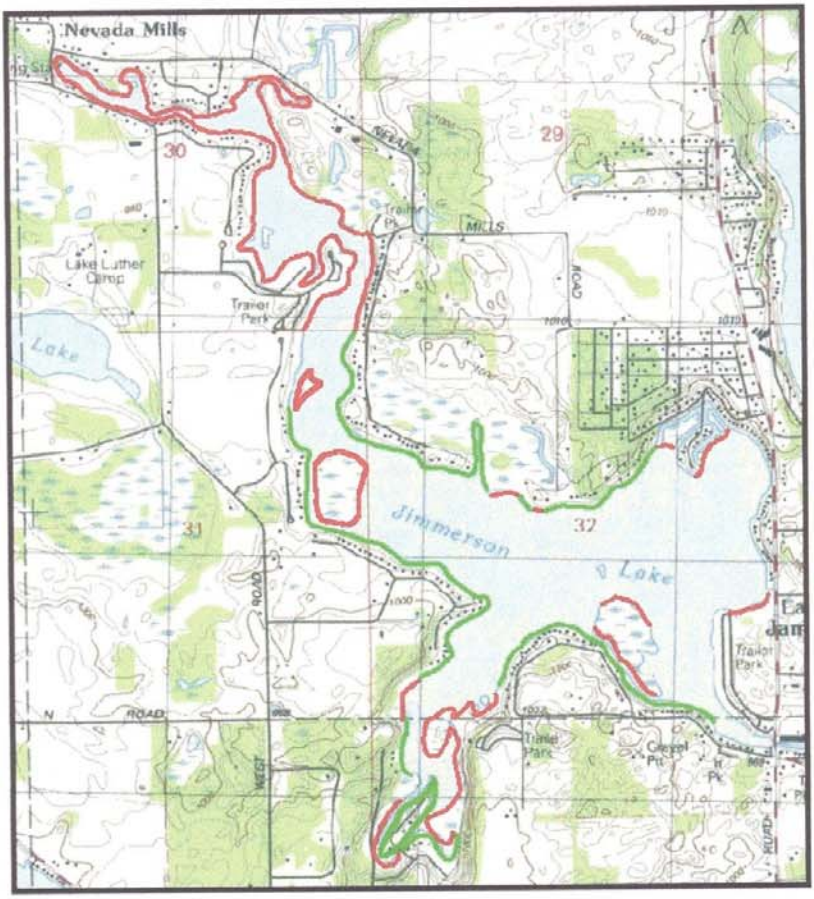
Trophic status of Jimmerson Lake was first determined by data collected in 1975. The Trophic Index was 22 on a scale of 0 (oligotrophic) to 75 (hypereutrophic).

Indiana Natural Resources Commission, 1996. Wetlands within public freshwater lakes. Indiana Register 19:940-953

Includes a map showing wetland profiles (significant wetlands and areas of special concern). This map is shown in Figure 2.

Figure 2. Significant Wetlands on the Lake Shoreline

# JIMMERSON LAKE
## STEUBEN COUNTY




INDIANA DEPARTMENT OF NATURAL RESOURCES

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

ANGOLA WEST QUADRANGLE

SIGNIFICANT WETLAND
AREA OF SPECIAL CONCERN

NOT TO SCALE

Indiana Department of Natural Resources, 1998. Indiana lakes exotic plant survey. Lake and River Enhancement Program, Indianapolis, IN

Information was collected by IDNR on the presence of exotic plants in Indiana lakes. On Jimmerson Lake, both Eurasian watermilfoil and curly-leaf pondweed were found to be "common."

Indiana Department of Environmental Management, 1996. Indiana Lake Water Quality Update for 1989-1993.

Trophic status of the lake was determined during the 1990s. The IDEM Trophic Index had improved to 9.

Frey, D.G, 1955. Distributional ecology of the cisco in Indiana. Investigations of Indiana Lakes and Streams 4: 177-228, Indiana Univ. Dept. of Zoology.

During 1952, the author collected water quality data from Jimmerson Lake to determine whether cisco (a fish which requires very high water quality) could maintain a viable population there. The lake's "cisco" layer (where water temperature did not exceed 20 degrees C and dissolved oxygen remained greater than 3 mg/l) was less than 1 foot. Local fishermen reported that cisco were present, though not abundant.

USGS, 2002. Water resources data: Indiana. Water year 2001. Report # IN-01-1, Water Resources Division, Indianapolis IN

The legal level of Jimmerson Lake, as established by the Steuben County Circuit Court in 1947, is 964.93 feet above sea level (a staff gauge level of 4.66 feet). The highest level recorded since 1937 is 6.22 feet (May. 27, 1943), while the lowest level has been 3.71 feet (Feb. 16, 1948). During a typical year, lake level varies by 1 foot between maximum and minimum.

SPEA, 1998. Secchi Disk Summary Data - 1998. Indiana University, Bloomington, IN

Volunteer monitoring data for Jimmerson Lake. The Carlson TSI values place the lake in the "eutrophic" category.

Ledet, N.D. and L.A. Koza, 2000. IDNR Fish Management Report. Jimmerson Lake.

IDNR fisheries biologists collected fish from the lake during the summer of 2000. They also conducted a creel survey of fishermen. The most frequently caught fish in the creel survey were bluegill (83%) and redear (12%) with an estimated total weight of 5700 pounds (the largest fish yield of five lakes studied in the Lake James chain of lakes. Local lake residents accounted for about half the fishermen interviewed for the creel survey. In the fisheries surveys conducted by biologists, bluegill (41%) and yellow bullhead (17%) were numerically dominant, but 19 additional species were present. No cisco were caught, indicating that this environmentally-sensitive fish, formerly present in the lake, may still not have the proper combination of high dissolved oxygen and low temperature to survive in the lake. No diseased fish were observed. No serious shoreline erosion or nuisance aquatic plant growths were noted. The IDNR fisheries biologists recommended that the lake be stocked with walleyes as they become available at the hatcheries.

Indiana Department of Environmental Management, 2000. Indiana Water Quality (305b) Report.

Jimmerson Lake is on the report's "impaired waterbodies" list due to a fish consumption advisory for mercury.

Indiana Department of Environmental Management, 1970. Unpublished file information on a bacteriological survey of Jimmerson Lake.

Samples were collected at 15 sites along the lakeshore. Only two sites (a log cabin on the southeast side of the lake and the mouth of the channel from Buena Vista) had detectable levels of fecal coliform bacteria. These samples had only 20 cfu/100 ml, which was well below the maximum Indiana water quality standard for recreational uses established at the time (1000 cfu/100 ml).

## B. SUMMARY OF AVAILABLE INFORMATION

Despite a growing number of lakeside homes and much higher boat use, water quality of Jimmerson Lake seems to have improved significantly during the past 50 years. Nutrient levels are lower than most Indiana lakes and water clarity has improved.

The Jimmerson Lake watershed has a wealth of wetlands and associated aquatic species not found in most other areas of Indiana. Most of the lake's shoreline has been designated as a significant wetland or an area of special concern by the Indiana Department of Natural Resources (IDNR). Exotic aquatic species such as eurasian watermilfoil have invaded the lake but are not yet abundant.

The lake has a healthy fish community. Exotic species such as carp are not present. A new walleye fishery is planned by IDNR. State-endangered cisco are no longer present in the lake. The lake is considered "impaired" by IDEM due to a fish consumption advisory for mercury. The source of mercury contamination is unknown but most contamination is thought to come from airborne sources rather than local inputs.

Pathogenic bacteria levels in the lake are low. Risk of bacterial infection to swimmers is low.

# III. COLLECTION OF ADDITIONAL NECESSARY INFORMATION

WHAT ADDITIONAL INFORMATION DO WE NEED TO MAKE GOOD DECISIONS ABOUT LAKE MANAGEMENT IN THIS WATERSHED?

A. Annual water budget
B. Endangered, threatened and rare species in the area
C. Numbers and kinds of livestock in the watershed
D. Stormwater management practices in the watershed
E. Number of permanent and seasonal residents
F. Wetland quality
G Water and sediment measurements at inlet sites
H. Wastewater treatment information
I. Land use information in the watershed
J. Boat use
K. Aquatic plant survey
L. Soils

## A. ANNUAL WATER BUDGET

This information was prepared using available data on watershed size, average evaporation rate, and local precipitation. The size of each sub watershed was obtained from the U.S. Geological Survey [1]. In the Fawn River, each square mile of watershed area is associated with an average of 7.5 gallons of runoff per second [2]. Some calculations were made which include Lake James, since these two lakes are only narrowly separated and tend to function as one waterbody.

| INPUTS | area (square miles) | annual input (billion gallons) |
|---|---|---|
| Crooked Creek | 48 | 11.7 |
| Other tributaries | 2 | 0.5 |
| Local runoff | 2 | 0.5 |
| Groundwater | | 0.1 |
| Direct Precipitation | | 0.7 |
| **OUTPUTS** | | |
| Jimmerson Lake outflow | | 12.7 |
| Evaporation | | 0.7 |
| Seepage | | 0.1 |

The following information was prepared using data from the Indiana Lake Classification and Management Plan. Volume and detention time calculations were made by plugging available data into the Eutromod computer model.

| | Lake Surface Area hectares | Mean Depth meters | Estimated Volume cubic meters |
|---|---|---|---|
| Jimmerson | 115 | 11 | 12.7 million |
| James | 419 | 12 | 49.1 million |

Mean residence time of a gallon of water is only 100 days for Jimmerson Lake. For the two lakes combined, mean residence time is 325 days.

## B. ENDANGERED, THREATENED AND RARE SPECIES AND HIGH QUALITY NATURAL AREAS

The IDNR Natural Heritage Program catalogues the presence of endangered, threatened, and rare species and high quality natural areas in Indiana. On September 5, 2002, Ronald Hellmich of the Indiana Natural Heritage Data Center provided the following on-file information from the Jimmerson Lake area:

| TYPE DATE | SPECIES NAME COMMENTS | COMMON NAME | STATE | FED | LOCATION | |
|---|---|---|---|---|---|---|
| Bird | CHLIDONIAS NIGER | BLACK TERN | SE | ** | T37NR13E LAKE JAMES | 1948 |
| Bird | CHLIDONIAS NIGER | BLACK TERN | SE | ** | T38NR13E 32 SEQ | 1986 |
| Bird | CISTOTHORUS PALUSTRIS | MARSH WREN | SE | ** | T38NR13E 32 | 1987 |
| Bird | RALLUS ELEGANS | KING RAIL | SE | ** | T38NR13E LAKE JAMES | 1939 |
| Bird | WILSONIA CANADENSIS | CANADA WARBLER | ** | ** | T38NR13E 31 CENTER WH | 1979 |
| Fish | COREGONUS ARTEDI | CISCO | SSC | ** | T38NR13E 32 SH & SH NH | 1955 |
| Insect | LYCAENA DORCAS DORCAS | DORCAS COPPER | ** | ** | T38NR13E 31 | 1984 |
| Mammal | CONDYLURA CRISTATA | STAR-NOSED MOLE | SSC | ** | T38NR13E LAKE JAMES AREA | 1941 |
| Vascular Plant | ANDROMEDA GLAUCOPHYLLA | BOG ROSEMARY | SR | ** | T38NR13E 31 NWQ | 1995 |
| Vascular Plant | PYROLA ASARIFOLIA | PINK WINTERGREEN | SE | ** | T38NR13E 31 | 1979 |
| Vascular Plant | SALIX SERISSIMA | AUTUMN WILLOW | ST | ** | T38NR13E 32 SEQ NWQ | 1983 |
| Vascular Plant | SCIRPUS SUBTERMINALIS | WATER BULRUSH | SR | ** | T38NR13E 32 SWQ SWQ | 1983 |
| Vascular Plant | UTRICULARIA PURPUREA | PURPLE BLADDERWORT | SR | ** | T38NR13E 32 SWQ SWQ | 1983 |
| Wetland | WETLAND - BEACH MARL | MARL BEACH | SG | ** | T38NR12E 25 SEQ | 1983 |
| Wetland | WETLAND - FLAT MUCK | MUCK FLAT | SG | ** | T38NR13E 32 SWQ SWQ | 1997 |
| Wetland | WETLAND - MARSH | MARSH | SG | ** | T38NR13E 032 WH SEQ | 1994 |
| BINKLEY BOG | | | | | | |
| Reptile | CLEMMYS GUTTATA | SPOTTED TURTLE | SE | ** | T38NR13E 31 SEQ NWQ | 1989 |
| Vascular Plant | CAREX DISPERMA | SOFTLEAF SEDGE | SE | ** | T38NR13E 31 CENTER | 1982 |
| Vascular Plant | ERIOPHORUM GRACILE | SLENDER COTTON-GRASS | ST | ** | T38NR13E 31 SWQ SEQ NWQ | 2001 |
| Wetland | WETLAND - BOG CIRCUMNEUTRAL | CIRCUMNEUTRAL BOG | SG | ** | T38NR13E 31 CENTER WH | 1979 |
| Wetland | WETLAND - FEN FORESTED | FORESTED FEN | SG | ** | T38NR13E 31 CENTER WH | 1979 |

JIMMERSON LAKE WETLAND CONSERVATION AREA

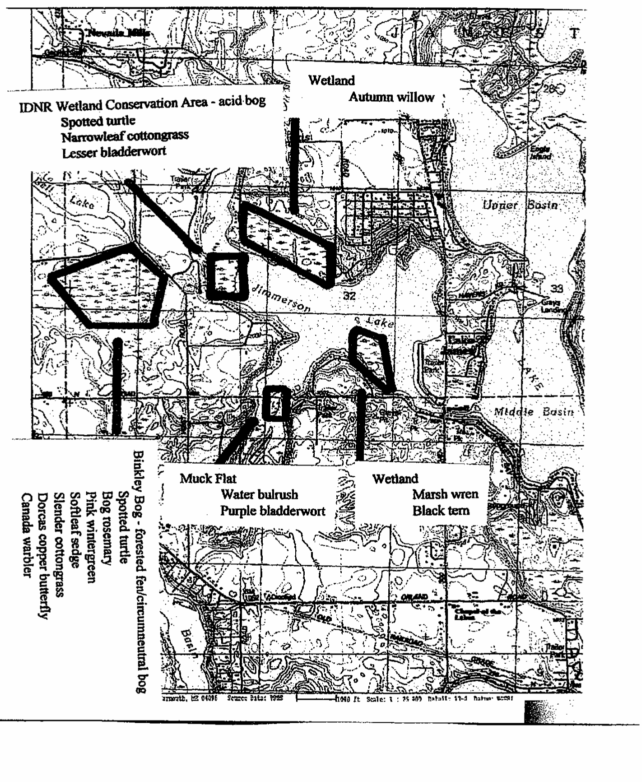
| | | | | | | |
|---|---|---|---|---|---|---|
| Reptile | CLEMMYS GUTTATA | SPOTTED TURTLE | SE | ** | T38NR13E 31 SEQ NEQ | 1983 |
| Vascular Plant | ERIOPHORUM ANGUSTIFOLIUM | NARROW-LEAVED COTTON-GRASS | SR | ** | T38NR13E 31 SEQ NEQ | 1983 |
| Vascular Plant | UTRICULARIA MINOR | LESSER BLADDERWORT | SE | ** | T38NR13E 31 SEQ NEQ | 1984 |
| Wetland | WETLAND - BOG ACID | ACID BOG | SG | ** | T38NR13E 31 EH SEQ NEQ | 1983 |
| Wetland | WETLAND - MARSH | MARSH | SG | ** | T38NR13E 31 EH SEQ NEQ | 1994 |

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant, ** no status but rarity warrants concern

FEDERAL: LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, E/SA=appearance similar to LE species, **=not listed

Sites mentioned in the database are shown in Fig. 3. Photographs of some of these unique biological resources are shown in a "flier" in the Appendix.

Fig. 3. Location of rare aquatic species and communities



## C. LIVESTOCK AND SEPTAGE IN THE WATERSHED

Because livestock are potentially important sources of nutrients in watersheds, it is often useful to know how many are present. However, livestock don't appear to be a factor in this diagnostic study. There are few livestock present in the four square miles of the immediate lake watershed. Wildlife such as Canada geese could represent a significant source of nutrient loading to the lake. Local residents have observed as many as 3000 geese present on the lake. Over the course of a year, droppings from this many waterfowl could contribute as much as 1500 pounds of phosphorus and 4000 pounds of nitrogen per year, especially if they feed primarily outside the watershed but leave their droppings primarily within the lake [15]. It is unlikely that this occurs, however, and waterfowl are probably not an important contributor to lake nutrients. Feeding waterfowl to attract a larger resident flock should be discouraged.

There are three "land application" sites for human septage in the watershed, all within Jamestown Township about a mile north of the lake. Shorty's Sewer Service uses a 70 acre site in section 29, Eyster Sewer Service has two sites. One is 5 acres in Section 21, the other is 7 acres in Section 29. All of these sites are legally permitted by the Indiana Department of Environmental Management. Septage is injected into the ground or treated with lime to reduce pathogens.

## D. STORMWATER MANAGEMENT PRACTICES

Urban stormwater runoff is an important source of nutrient loading in many lake watersheds. Although Jimmerson Lake does not appear to be an "urban" area, there are many acres of paved roads and driveways in the watershed. An estimate of phosphorus loading from urban runoff in the 4 square mile area immediately surrounding the lake was calculated using the following assumptions:

Urban Area = 40 ha (determined by aerial photography)
Annual Precipitation = 1 meter
Average P Concentration = 0.46 mg/l (U.S.EPA [10] average for urban areas)
Runoff Coefficient = 40% (D.M Gray, Principles of Hydrology)

| | |
|---|---|
| Total Area | 400,000 square meters |
| Total Volume | 400,000 cubic meters |
| Total Annual Runoff | 160,000 cubic meters per year |
| | 17,000,000 liters per year |
| Total Annual P Loading from Urban Sources | 9 kg |

Simply controlling runoff from paved areas draining directly into the lake could reduce phosphorus inputs by 9 kilograms (20 pounds) annually. Target areas for control will be discussed in Section V.

## E. PERMANENT AND SEASONAL RESIDENT DATA

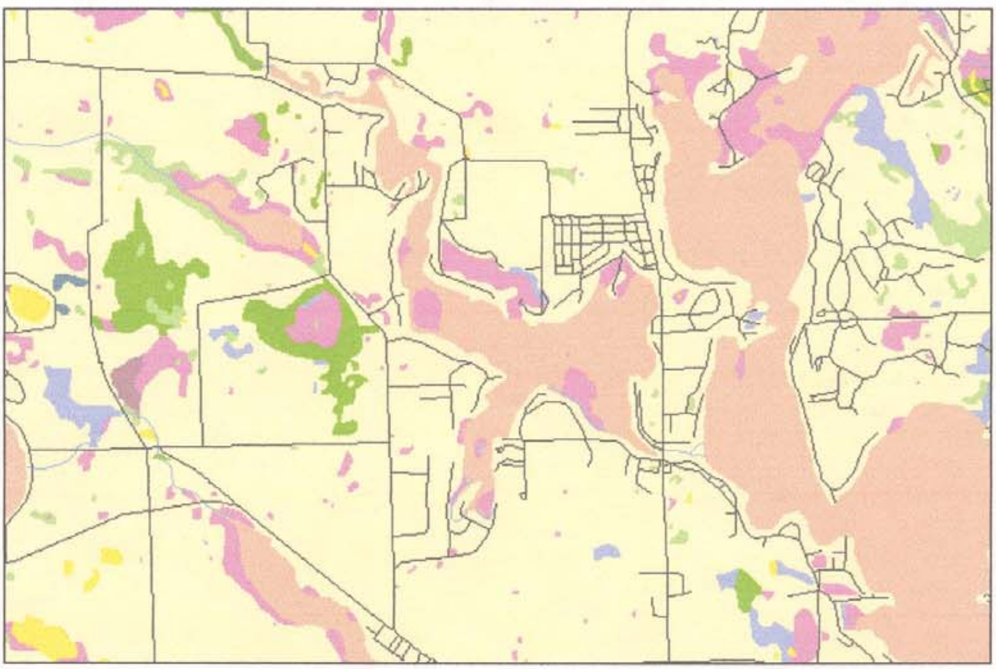
The Jimmerson Lake Association conducted a survey as part of this study to determine how many homes are on the lake and how these are distributed by use as permanent and seasonal dwellings. The association found a total of 816 residences with lakeshore property or lake access. Of these, 333 were permanent and 483 were seasonal. The association also estimated changes over the past 10 years. They found that the number of permanent dwellings had increased by 32 and the number of seasonal-use dwellings had increased by 70. The total number of homes on the lake has increased by 14% in the past 10 years.

An examination of land use in 2002 found that 75% of the Jimmerson Lake shoreline was used for homes, 20% was wetland, and 5% was forested [14].

## F. WETLANDS

There are numerous wetlands in the watershed. A map of wetlands based on the National Wetland Inventory maps is shown in Figure 4. Most of these are "palustrine" (shallow, freshwater, not flowing) with a high potential for sediment and nutrient filtration.

Fig. 4. Watershed wetlands



## G. WATER AND SEDIMENT MEASUREMENTS AT INLETS

Except for the Crooked Creek inlet to Jimmerson Lake from Lake James, there are no permanently flowing streams in the watershed. Therefore, dry weather samples were not collected. Instead, water samples were collected at several inlet sites during wet weather on two occasions. The sampling sites are shown in Fig. 5. Results of analyses are shown in Table 1.

Table 1. Water quality measurements at lake inlets

Wet weather - August 20, 2002 (24-hr precipitation = 0.48 inches)

| | NH3 mg/l | NO3 mg/l | TKN mg/l | Orth-P mg/l | Tot-P mg/l | TSS mg/l | TDS mg/l | Alk. mg/l | Hard. mg/l | E.coli /100 ml | ChlA ug/l | Turb. NTU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site 1 | 0.3 | 1.2 | 1.8 | 0.48 | 0.5 | 10 | 532 | 140 | 301 | 376 | 333 | 0.4 |
| Site 2 | 0.3 | <0.3 | 2.3 | 0.13 | 0.23 | 103 | 371 | 88 | 224 | 35 | 1600 | 8.2 |
| Site 3 | 0.2 | 0.7 | 1.4 | 0.22 | 0.2 | 15 | 496 | 108 | 210 | 20 | 462 | 3.2 |
| Site 4 | 2.2 | <0.3 | 39.4 | 0.12 | 4.4 | 166 | 881 | 120 | 238 | 204 | 4980 | 12.8 |
| Site 5 | 0.2 | <0.3 | 2.4 | 0.07 | 0.57 | 34 | 437 | 128 | 210 | 40 | 381 | 2.7 |

Wet weather - August 27, 2002 (24-hr precipitation = 0.83 inches)

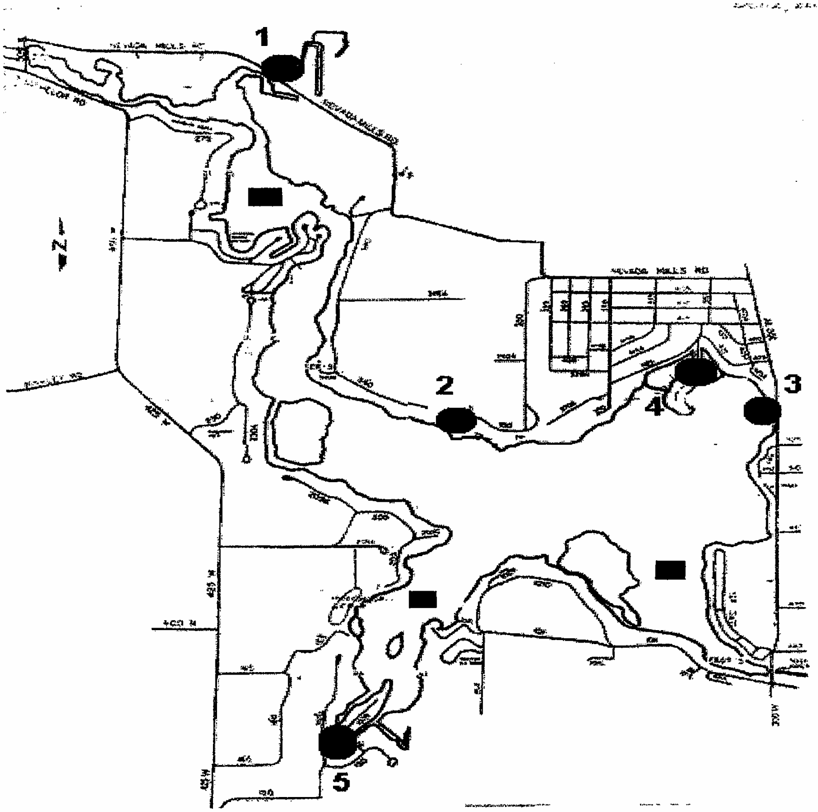
| | NH3 mg/l | NO3 mg/l | TKN mg/l | Orth-P mg/l | Tot-P mg/l | TSS mg/l | Alk. mg/l | Hard. mg/l | E.coli /100 ml | ChlA ug/l | Turb. NTU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site 1 | 0.4 | 1.7 | 1.0 | 0.08 | 0.10 | 5 | 168 | 322 | 77 | 237 | 0.6 |
| Site 2 | 0.2 | <0.3 | 10.0 | 0.17 | 0.60 | 913 | 120 | 189 | 40 | 4334 | 104 |
| Site 3 | 0.2 | 1.8 | 5.0 | 0.10 | 0.36 | 22 | 64 | 133 | 176 | 390 | 2.6 |
| Site 4 | <0.1 | <0.3 | 1.8 | 0.09 | 0.46 | 11 | 92 | 203 | 9 | 501 | 1.5 |
| Site 5 | 0.1 | <0.3 | 15.1 | 0.13 | 0.68 | 417 | 96 | 224 | 29 | 3516 | 27 |

Chemical monitoring data from Lake James, collected by SPEA in 1989, 1992, 1997, and 2002, was used to calculate the dry weather inlet values, Water column averages were used to generate the data. These are shown in Table 2.

Table 2. Water column averages of nutrient inputs from Lake James

| | NH3 mg/l | NO3 mg/l | TKN mg/l | Orth-P mg/l | Tot-P mg/l |
|---|---|---|---|---|---|
| 1989 | 0.41 | 0.58 | 0.90 | 0.016 | 0.10 |
| 1992 | 0.16 | 0.93 | 0.84 | 0.004 | 0.05 |
| 1997 | 0.29 | 0.02 | 0.85 | 0.007 | 0.02 |
| 2002 | 0.22 | 0.08 | 0.68 | 0.010 | 0.02 |
| AVE | 0.27 | 0.40 | 0.82 | 0.009 | 0.05 |

Fig. 5. Sampling Sites
Circles are water samples, squares are sediment samples




The samples collected in this part of the study were intended to determine whether nutrients (nitrogen as ammonia, nitrate, TKN and phosphorus as total and ortho-P), *E.coli* bacteria (indicators of potential swimming-related illness), or turbidity-causing pollutants were present in storm water runoff. Sampling in two storm events showed that all local storm water runoff sites contribute to potentially harmful pollutant loading. Although the overall loading to the lake is relatively low because of their small watersheds, sites 2, 4, and 5 have nutrient concentrations much higher than the inflow from Lake James. Runoff control efforts should focus on these areas.

Samples of bottom sediments (fine silt) were collected by petite ponar dredge from three sites in the lake on August 31, 2002. Results are shown below and compared to values reported from Illinois lakes [7].

Table 3. Nutrient Levels in Bottom Sediments at Channel Inlets

| Site | Nitrogen mg/kg | Phosphorus mg/kg | Elevated? |
|---|---|---|---|
| North Basin | 16200 | 391 | Yes, for Nitrogen |
| South Basin | 10650 | 163 | Yes, for Nitrogen |
| East Basin | 6720 | 89 | Yes, for Nitrogen |
| Illinois Mean [7] | 3400 | 600 | |

Phosphorus is usually the limiting nutrient for algae and aquatic plants in Indiana lakes. Therefore, the elevated nitrogen concentrations observed in Jimmerson Lake sediments are probably not detrimental to lake uses.

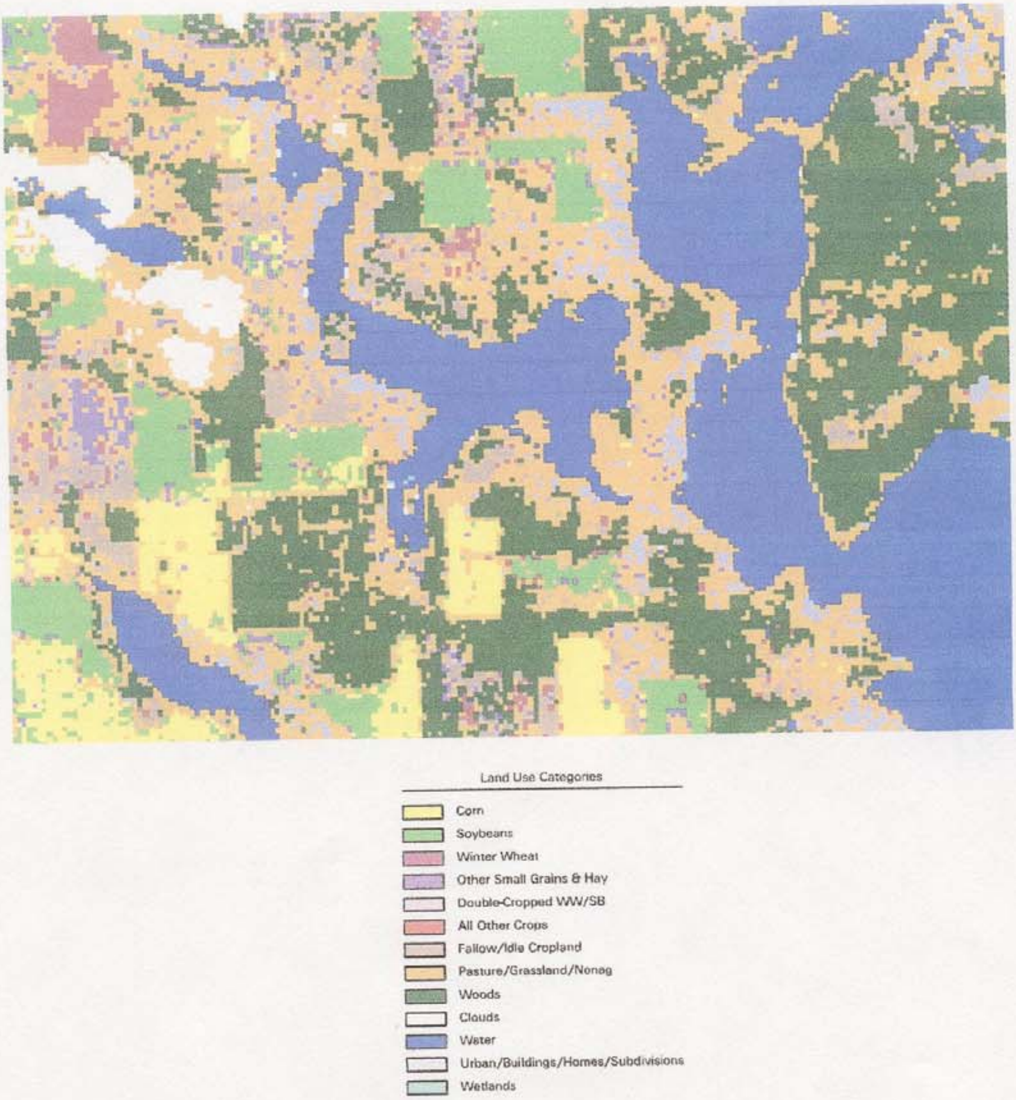
## H. WASTEWATER TREATMENT PRACTICES

Most homes on Jimmerson Lake are served by septic tanks. However, this is about to change, as most homes on the lake will be hooked up to the Steuben Lakes Regional Sewer District by 2003. The potential effect of this change will be discussed in more detail in Section IV.

# I. LAND USE INFORMATION IN THE WATERSHED

Land uses, obtained from a satellite photograph of the area in the summer of 2000 (National Agricultural Statistics Service), are shown in Figure 6. Nearly 90% of the land use in the watershed is agricultural, including livestock production, row crop agriculture, and pasture.

Fig. 6. Watershed land use



In the 4-square mile drainage area around Jimmerson Lake, the following land use percentages occur:

| | | |
|---|---|---|
| Row crop agriculture | 25% | |
| Forest | 18% | |
| Wetland | 12% | |
| Urban/built-up land | 5% | |
| "Grassland" | 40% | (this includes pasture, uncultivated fields, and residential yards) |

## J. BOAT USE

The Jimmerson Lake Association conducted a survey of boats present on the lake during the third week of September 2002. They did this by counting all powered watercraft at each dock (a vacant dock and lift was counted as one boat, since some boats had already been removed for the season). A total of 1188 boats were counted. This is only the number of boats used by residents. Additional boats launched from the public access boat ramps were not included.

## K. AQUATIC PLANT SURVEY

Fisheries biologists from the Indiana Department of Natural Resources conducted an aquatic plant survey of Jimmerson Lake on July 18, 2000. They collected plants from ten transects evenly distributed throughout the lake. Twenty-seven species were identified. The aquatic plant community was dominated by bladderwort, chara, Eurasian watermilfoil, eelgrass, and white waterlily. A summary of the data is shown below:

Table 4. Summary of aquatic plants from the lake

| | Percent of Transects Containing the Species | Average Dominance Per Transect (%) |
|---|---|---|
| American elodea | 10 | 0.5 |
| Arrowhead | 30 | 0.8 |
| Bladefooted quillwort | 20 | 0.3 |
| Bladderwort | 50 | 13.1 |
| Brittle naiad | 10 | 0.2 |
| Buttonbush | 10 | 0.1 |
| Cattail | 10 | 0.3 |
| Chara | 60 | 18.5 |
| Coontail | 10 | 0.5 |
| Curlyleaf pondweed | 20 | 0.2 |
| Eel grass | 60 | 5.7 |
| Eurasian watermilfoil | 50 | 10.0 |
| Fern pondweed | 10 | 0.1 |
| Flat-stemmed pondweed | 50 | 1.4 |
| Floatingleaf pondweed | 10 | 0.5 |
| Leafy pondweed | 20 | 0.4 |
| Pickerel weed | 10 | 0.1 |
| Purple loosestrife | 10 | 0.1 |
| Sago pondweed | 10 | 0.5 |
| Slender naiad | 10 | 0.1 |
| Softstem bulrush | 10 | 1.0 |
| Southern naiad | 10 | 0.5 |
| Spatterdock | 20 | 0.4 |
| Spiny naiad | 10 | 0.2 |
| Variable pondweed | 40 | 1.5 |
| White waterlily | 60 | 4.2 |
| Whitestem pondweed | 20 | 0.6 |

The Jimmerson Lake Association sponsors an aquatic plant management program each year. Herbicides are applied in up to 19 areas of the lake. Approximately 23,000 feet of shoreline and 47 total acres are treated to keep the lake accessible to swimmers and boaters.

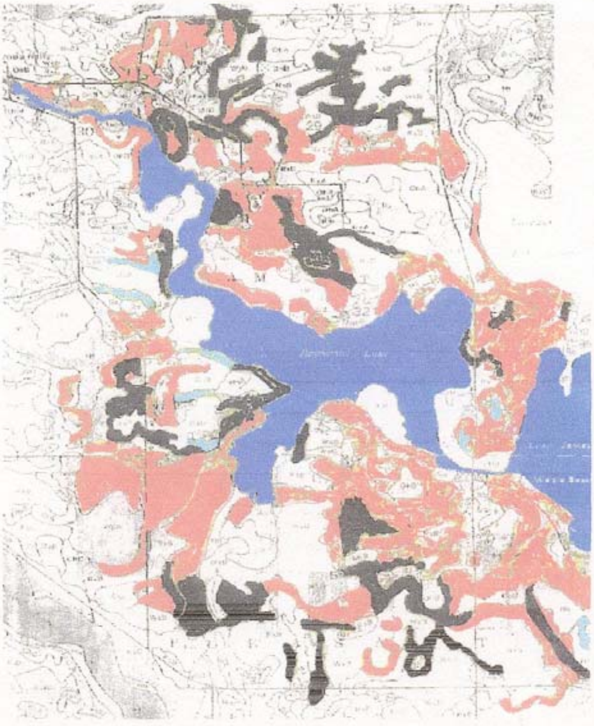
## L. LOCAL SOIL INFORMATION

According to the Steuben County soils map [15], there are eight main soil types in the immediate watershed area surrounding Jimmerson Lake: Wawasee, Riddles, Casco, Boyer, Kosciusko, Oshtemo, Metea, and Chelsea. Their erosion potential is indicated by their K value, with the highest K values being the most erodible.

| | | |
|---|---|---|
| 1 | Casco | 0.32 |
| 2. | Wawasee | 0.28 |
| 3. | Riddles | 0.24 |
| All Others | | 0.17 |

Soils with the steepest slopes are most vulnerable to erosion. These are indicated on the soils maps with the modifier of C (6-12% slope), or D (12-18% slope) and are shown in Fig 7. The soils in the watershed most vulnerable to erosion are Casco C and Wawasee D. Casco C soils are shown in light blue, Wawasee D soils are shown in black. Other erodible soils are shown in red. If disturbances to these soils are necessary, very stringent erosion control measures should be employed to prevent runoff of sediment and nutrients to Jimmerson Lake.

Fig. 7. Soils on steep slopes



## IV. Modeling

The computer model Aquatox [3] was used to determine how biological conditions would be expected to change with reductions in pollutant loads to Jimmerson Lake. Fig. 8 shows how the biology of the lake might respond to nutrient reductions. Fig. 9 shows calculated reductions of in-lake nutrients that would occur during the first year if loadings are reduced by 50% (a reasonable goal achieved in other watersheds).

Fig. 8. In-lake biological changes expected to occur with nutrient reductions

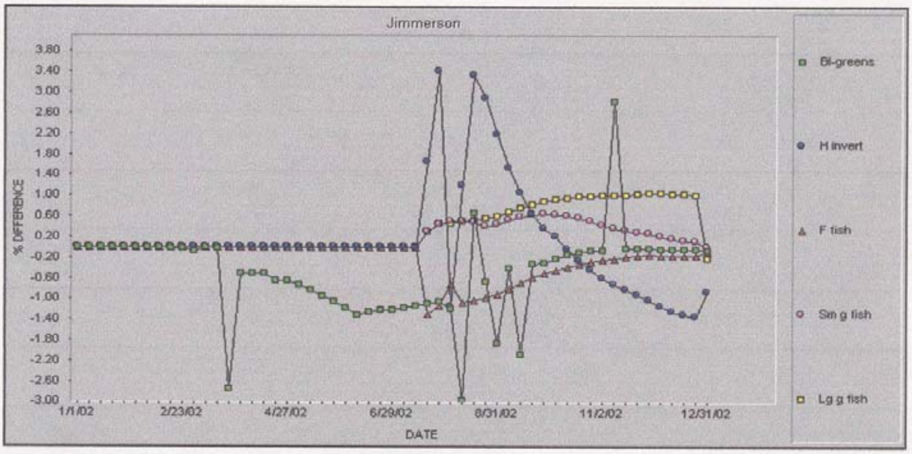
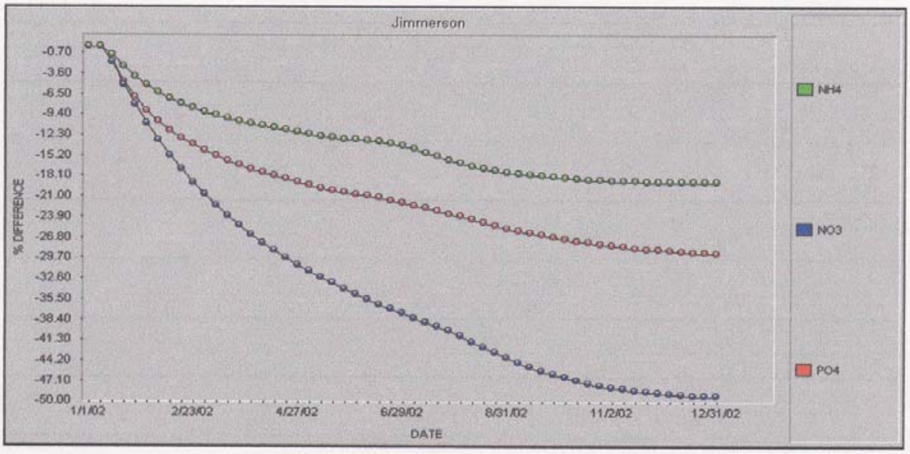



Fig. 9. In-lake chemical changes expected with watershed management



Figures 8 and 9, generated by AQUATOX, show that nutrient loading would begin to decrease almost immediately, resulting in levels 20-50% lower within one year. Biological responses to this change include increases in invertebrates and large game fish and decreases in bluegreen algae growths.

The EUTROMOD model developed by Duke University [16] allows estimates of nutrient loading based on land use in the watershed. Certain types of land use generate a predictable nutrient loading. As land uses change, the changes in nutrient loading will affect lake water quality. Because Lake Jimmerson and Lake James are so closely tied together (only a very short channel separates them), the model treated them as a single lake. The following data were used in the model:

| | |
|---|---|
| Agricultural Land Use | 12000 ha |
| Forest Land Use | 1000 ha |
| Urban Land Use | 100 ha |
| Fallow Grass Land Use | 1000 ha |
| Number of Septic Tank Users | 3000 |
| Lake Area | 5.2 sq. km |
| Mean Depth | 11 m |

The model predicts the following results with present land uses (actual sampling results from this study and from historical data [14] are shown for comparison):

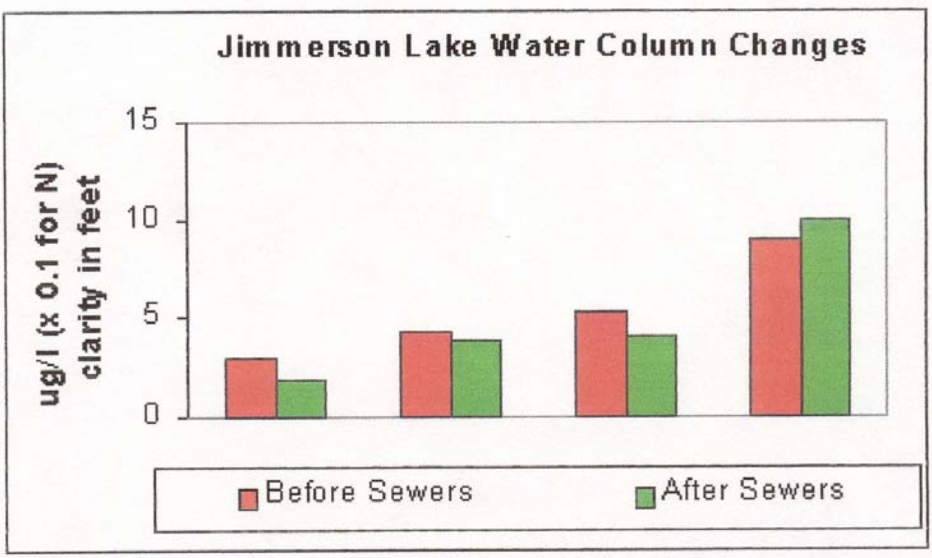
| | Predicted | Actual |
|---|---|---|
| Feeder stream Phosphorus | 0.04 mg/l | 0.12 mg/l |
| Feeder stream Nitrogen | 1.0 mg/l | 4 mg/l |
| Water column Phosphorus | 0.03 mg/l | 0.03 mg/l |
| Water column Nitrogen | 0.4 mg/l | 1.1 mg/l |
| Chlorophyl a | 5.3 ug/l | 7 ug/l |
| Secchi Depth | 3.0 m | 2 m |
| Trophic Status Index | 49 | 57 |

The predicted vs. actual values are reasonably close for almost all parameters. The Eutromod model appears to be very effective at predicting lake responses to various changes in land use in the Jimmerson Lake watershed.

A single change in the model assumptions can cause large changes in model outcome. For example, the Steuben County Regional Sewer District will eliminate almost all septic tank use in the watershed by next year. What effect will eliminating the pollutants from leaking septic tanks have on water quality? The model was re-run with this potential source of pollutant loading eliminated. Predicted changes are shown in Figure 10. Phosphorus, nitrogen, and algae will decline. Water clarity will increase by about one foot. This has a real and measurable economic value. A recent study of Maine property values on lakes [11], found that a 1 foot increase in water clarity increased property values by about 2%. If the average lakefront property sells for $250,000 today, the value of the sewer project is roughly $5000 per homeowner. Since there are more than 800 residences on Jimmerson Lake, the total value for the lake is over four million dollars.

A summary of the model results is included in the Appendix.

Figure 10.



V. Trend Analysis

When water quality measurements are taken at the same place over a period of time, it is often possible to chart trends. An example of this type of measurement are the numerous Secchi disk readings taken in the lake by professionals or trained volunteers each year in July and August. The summer mean Secchi disk readings (in feet) for Jimmerson Lake are shown below:

| | | | |
|---|---|---|---|
| 1989 | 10.2 | 1995 | 9.9 |
| 1990 | 10.8 | 1996 | 9.5 |
| 1992 | 12.4 | 2000 | 9.0 |
| 1993 | 9.8 | 2001 | 9.5 |
| 1994 | 7.3 | 2002 | 12.0 |

Summer Secchi depth values are somewhat variable and changes of 2 or 3 feet in transparency are common in Indiana lakes. No clear trend in water transparency emerges from these data. The long-term average Secchi depth for Jimmerson Lake is about 10 feet and this value has remained relatively constant during the past 25 years.

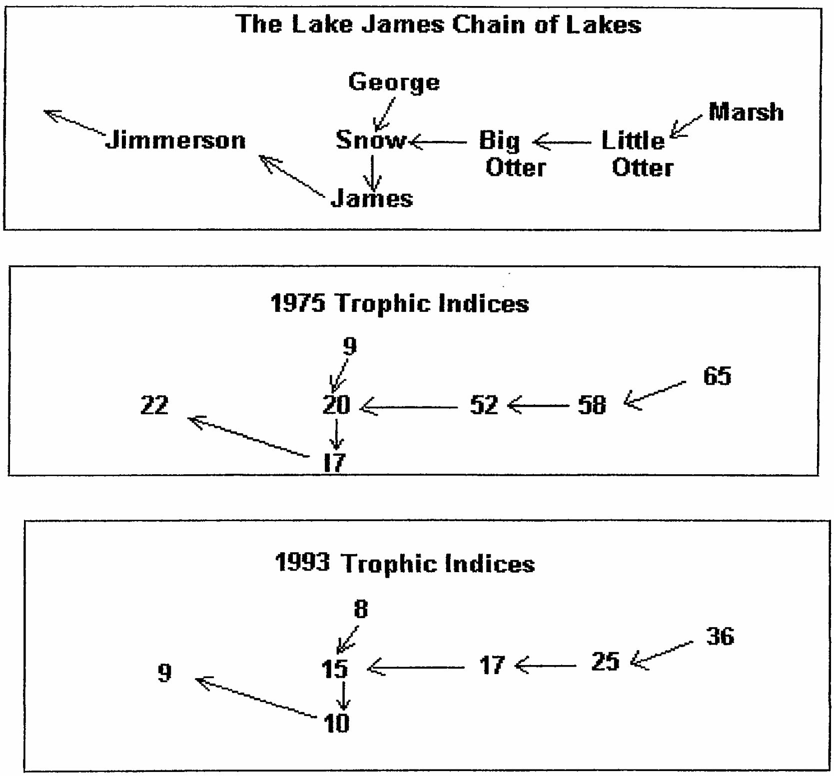
The IDEM Clean Lakes Program, administered by the Indiana University SPEA staff, has measured water chemistry of Indiana lakes regularly since 1989. Data from IDEM in the 1970s are also available. A summary of these data (combined epilimnion and hypolimnion values) for several lake nutrients is shown in Table 5

Table 5. Jimmerson Lake Nutrients (1975-2002)

| | Total Phosphorus (mg/l) | Nitrate (mg/l) | Ammonia (mg/l) | Organic Nitrogen (mg/l) | Total Nitrogen (mg/l) |
|---|---|---|---|---|---|
| 1975 | 0.040 | 0.20 | 0.10 | 0.70 | 1.00 |
| 1989 | 0.090 | 0.52 | 0.74 | 0.80 | 2.06 |
| 1992 | 0.028 | 0.67 | 0.24 | 1.10 | 2.01 |
| 1997 | 0.028 | 0.72 | 0.03 | 1.40 | 2.15 |
| 2002 | 0.030 | 0.03 | 0.41 | 0.76 | 1.20 |

The Indiana (BonHomme) Trophic Index Value is a multiparameter measurement of the trophic status of Indiana lakes. The value ranges from 0 (oligotrophic) to 75 (hypereutrophic). The first measurements began in the 1970s and are now made every five years by the Indiana University SPEA program. The index values provide an easy-to-understand method of tracking lake health over time. Figure 11 shows the progression of lakes in the Jimmerson Lake watershed. It also shows a summary of individual lake trophic indices from 1975 and from 1993. The index numbers decrease markedly from the headwater on Marsh Lake to Jimmerson Lake. This shows the role of upstream lakes in cleaning up water in a watershed. The figure also shows that there were significant improvements in water quality in each lake from 1975 to 1993. Parameters in the index showing the biggest improvements in Jimmerson Lake were reductions in phosphorus and nitrogen concentrations.

Fig. 11. Trophic Index Values over Time



Water column profiles of oxygen and temperature have been recorded in Jimmerson Lake since 1953 to record the size of the "cisco layer" (the layer during summer stratification at which enough oxygen occurs and temperatures are low enough to support the rare freshwater whitefish *Coregonus artedi*). A larger cisco layer indicates more pristine environmental conditions. The width of the layer during each year is shown in Table 6.

Table 6. Changes in the width of the "cisco layer" over time (Oxygen > 3 mg/l; Temp. < 20 C)

| Year | Cisco Layer Top/Bottom (feet) | Width (feet) | Reference |
|---|---|---|---|
| 1953 | 22-23 | 1 | [13] |
| 1975 | 19-26 | 7 | [12] |
| 1989 | 15-25 | 10 | [14] |
| 1997 | 18-20 | 2 | [14] |
| 2002 | 15-33 | 18 | [14] |

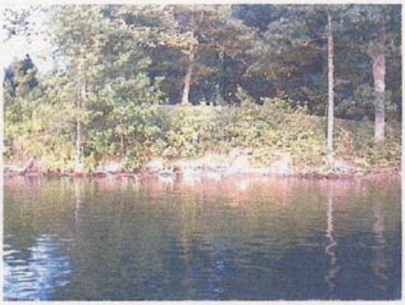
The width of the cisco layer seems to vary greatly from year to year. In some years, it barely exists, in others it is quite large. There is no clear trend over time.

## VI. IDENTIFICATION OF PROBLEMS

Jimmerson Lake does not have any emergency problems to address. Water quality is good and is not showing any signs of recent declines. However, the Jimmerson Lake Association wants to be pro-active by addressing potential problems that could eventually interfere with lake quality. Potential problems include:

1. Construction of new concrete seawalls. A proliferation of concrete seawalls has been shown to have a detrimental effect on lakes [18]. Concrete seawalls deflect wave energy to adjacent properties, causing shoreline erosion elsewhere. They create a barrier for reptiles, amphibians and other species that must travel to and from water to feed or complete their life cycles. They produce a barren near-shore area devoid of most plant and insect life that fish and wildlife feed on. Concrete seawalls also detract from natural shoreline beauty.

Shoreline with seawall

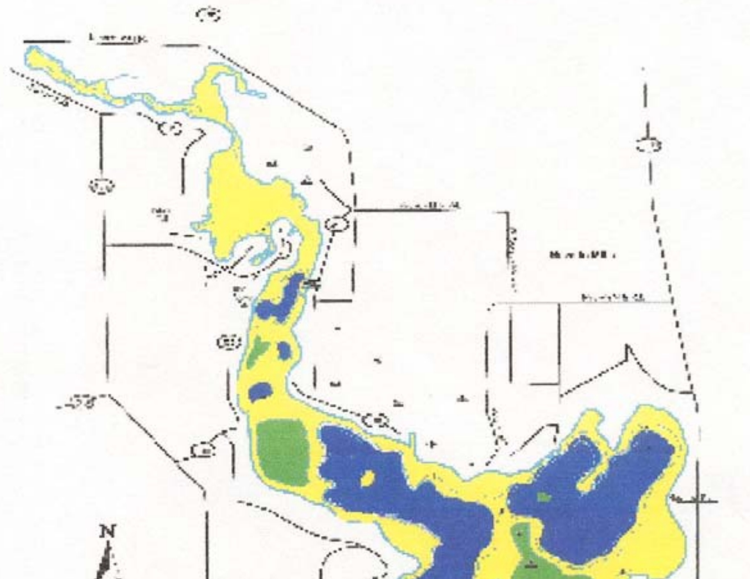


Natural shoreline

2. Despite the extremely high number of boaters using the lake and the potential for damaging wave action, there are still healthy stands of emergent aquatic vegetation present. Placing buoys around these vegetation beds early each summer will help keep high-speed boats from damaging these valuable fish spawning areas.

Aquatic plant beds in Jimmerson Lake occur in areas where water depth is less than 10 feet. Over half the lake is in this relatively shallow category. Most plant beds in the lake are in near-shore areas. However, there is also a bed of emergent wetland plants forming a small island in the middle of the lake. Local residents say this island's size has decreased by 50% in the past few years. Fig. 12 shows areas in the lake with aquatic plant beds.

Fig. 12
Shallow areas with extensive plant beds are in yellow
Floating islands are marked in green
Blue areas indicate deep water with no plants



3. The watershed immediately surrounding the lake has a high percentage of soils with slopes greater than 10%. These areas are vulnerable to erosion when the soils are disturbed or the vegetation removed.

4. A high percentage of the lakeshore is developed for residential purposes. Yards extending to the waterline are very common in most areas. Fertilizer use should be discouraged.

5. Undeveloped areas around the lake are increasingly uncommon. It may be necessary for the association to buy and manage some of the remaining wetlands and forested areas to make sure conservation practices are employed.

6. The Buena Vista area has a high density of housing and roads on steep slopes. That combination makes this area among the most vulnerable to erosion and excessive nutrient loading. A plan to reduce runoff from Buena Vista is desirable.

AGRICULTURAL "BEST MANAGEMENT PRACTICES"

"Best management practices" or BMPs are ways to use agricultural land to produce crops and raise livestock but at the same time minimize the amount of erosion and storm water runoff from the land. Some BMPs (e.g. vegetative filter strips, grassed waterways, water and sediment control basins, etc.) can be partially or completely funded by the local county Soil and Water Conservation District (SWCD) or through the DNR's Lake and River Enhancement program (funded as "watershed land treatments."). BMPs are especially important in areas where soils are easily erodible. Some of the land around Jimmerson Lake is used for agricultural where steep, erodible soils are present. Getting this land enrolled in a BMP project through the SWCD is important. The Steuben County SWCD office can be contacted at

URBAN STORM FILTERS

Storm filters for treatment of urban runoff are capable of removing 90% of fine sediment in the water. An example of such a filter and its use in a storm grate is shown in the Appendix. There are a few areas around the lake where storm sewers are present, especially in the Buena Vista neighborhood. Placing and maintaining storm filters on inlets would be valuable in these areas.

## NUTRIENT REMOVAL BY SEDIMENT DREDGING

Sediments from urban and agricultural areas often contain high levels of nutrients. These can be carried by streams and deposited in the still water areas of lakes. Ideally, nutrient-enriched sediments are trapped and periodically removed before they reach the lakes. Removing sediment from a sediment trap can be done without a permit. Dredging lake sediments also removes nutrients from the system. This type of dredging is usually more costly and requires both state and federal permits. Determining sites for sediment traps could be the focus of an "engineering feasibility study" in the LARE program.

## AQUATIC PLANT HARVESTING

Volunteer labor could be effective in reducing some of the phosphorus loading. Aquatic plants typically contain a large amount of phosphorus. A pound of dried plants may contain as much as 3 grams of phosphorus. Lakeshore property owners could manually remove and compost plants each summer. Composting is necessary so the nutrients do not run back into the lake as the algae decompose. There is no financial cost for this method of phosphorus removal. A hundred volunteers each harvesting 300 pounds of plants per summer could potentially remove up to 100 kg of phosphorus from the lake in the course of a year.

This type of phosphorus removal is effective both as a treatment and as an educational tool. Getting local lake associations personally involved with the project could serve as a way to get landowners along the lake shore to manage their property in more water-friendly ways. Organizing local "plant-harvest" competitions would help stimulate involvement.

Because aquatic plants function as important nursery areas for fish, harvesting should not be done until late summer. The areas for harvest should be planned in advance and include only common plant species. Indiana regulations limit the area of manual aquatic plant harvest to 650 square feet, unless a permit from the Indiana Department of Natural Resources is obtained.

## ALTERNATIVE METHODS OF AQUATIC PLANT CONTROL

Sediment covers such as polyethylene, polypropylene, fiberglass, nylon, and burlap have been used elsewhere as an alternative to herbicide application for controlling excessive growths of aquatic plants. In this technique, a sheet of material is placed on the lake bottom over existing plants, shading them out and creating a physical barrier for growth. .Advantages of this technique include:

* use is confined to a specific area
* they are out of sight and create no disturbance on shore
* no toxic chemicals are used
* they are easy to install

Problems sometimes exist with applications of materials. Potential disadvantages of sediment covers include:

* they can be more expensive than chemicals at first
* they are difficult to apply over large areas or over obstructions
* some materials are degraded by sunlight and will have to be replaced over time
* sediment deposition over covers may allow new plants to become established
* a permit is required from the Indiana Department of Natural Resources

Table 7 gives some characteristics and potential costs of different types of sediment covers [17].

Table 7. Sediment Covers

| Material | Specific Gravity | ~ Cost per acre | Gas Permeability | Application Difficulty | Comments |
|---|---|---|---|---|---|
| polyethylene | 0.95 | $3000 | None | High | "Gas balloons" |
| polypropyl | 0.90 | $5000 | Permeable | Low | Effective |
| nylon | >1 | $5000 | None | Moderate | Vents needed |
| burlap | >1 | $2000 | Permeable | Moderate | Rots quickly |

Polypropyl seems to be one of the most cost-effective, easily applied covers. It is sold by the name Typar. Indiana distributors for this product are:

Bill Bowling.. Brad Evans
MONSMA MARKETING
7800A Record Street
Lawrence IN 46226
(317) 545-0206

SUMMARY OF POTENTIAL PROJECT COSTS
(estimates from EPA [19] and other sources).

| | |
|---|---|
| BMP Land Treatments | |
| Conservation Tillage | $15 per acre |
| WASCOB | $1700 |
| Grassed Waterway | $4 per linear foot |
| Vegetated Buffer Strip | $90 per acre |
| Sediment Trap | $7000 plus land costs |
| Sediment Removal | $15 per cubic yard |
| Sediment Covers | $1 per square yard |
| Storm Filters | $100 per storm filter per year |
| Aquatic Plant Harvest | No cost |

# VII. PUBLIC PARTICIPATION

A public meeting was held December 14, 2002 at the Sunset Inn on Crooked Lake. Forty-three people attended (see participant list in the Appendix). There was a question and answer period. A flier (copy is in the Appendix) explained what the study was finding out about lake quality and how local people could help keep pollutants out of the water. The first outlines of a lake management plan were presented. Included in the plan were recommendations to:

* Protect steep slopes in the watershed with vegetation
* Apply caution in fertilizing lawns on the lake front
* Discourage the use of concrete seawalls on the lake. Promote natural shoreline vegetation and bio-engineered shoreline protection
* Find ways to reduce erosion and polluted runoff in the Buena Vista area
* Encourage farmers in the watershed to use best management practices
* Consider buying undeveloped wetlands and forested areas around the lake and manage them as conservation lands
* Place buoys around emergent aquatic plant beds in the lake to keep high-speed boat traffic from disturbing or uprooting the plants
* Consider using sediment covers in place of herbicides in some areas
* Encourage all upstream lake associations to do management plans

# VIII. REFERENCES


1. Hoggatt, R.E. 1975. Drainage areas of Indiana streams. U.S. Geological Survey, Water Resources Division, Indianapolis, IN.

2. Arvin, D.V. 1989. Statistical summary of streamflow data for Indiana. U.S. Geological Survey Open-file Report 89-62, Indianapolis, IN.

3. U.S.EPA, 2000. Aquatox for Windows. A modular fate and effects model for aquatic ecosystems. Office of Water, Washington, D.C. EPA-823-R-00-007.

4. Brown, W. and T. Schueler, 1997. National pollutant removal performance database for stormwater BMPs. Center for Watershed Protection, Silver Spring, MD.

5. Wetzel, R.G. 1975. Limnology. W.B. Saunders Company, Philadelphia PA. 743 pp.

6. Kelly, M.H. and R.L. Hite, 1981. Chemical analysis of surficial sediments from 63 Illinois lakes, summer 1979. Illinois EPA, Division of Water Pollution Control, Springfield IL. 92 pp.

7. Whitaker, J.O. and J.R. Gammon, 1988. Endangered and threatened vertebrate animals of Indiana: their distribution and abundance. Ind. Acad. Sci. Monograph Number 5. Indianapolis, IN.

8. Culp, R.L., G.M. Wesner, and G.L. Culp, 1978. Handbook of Advanced Wastewater Treatment. Van Nostrand Reinhold, NY.

9. U.S.EPA, 1983. Results of the Nationwide Urban Runoff Program. Vol. I . Final Report. EPA Water Planning Division, WH-554, Washington, D.C.

10. Harper, H.H. et al., 1992. The use of wetlands for controlling stormwater pollution. Woodward-Clyde Consultants, Portland, Ore. Prepared for US EPA Region V Watershed Management Unit, Chicago, IL.

11. Michael, H.J., K.J. Boyle, & R. Bouchard, 1996. Water quality affects property prices: a case study of selected Maine lakes. Maine Agricul. Forest Exp. Sta., Misc. Report 398. 18 pp.

12. Indiana Department of Environmental Management, 1975. Unpublished limnological data for Jimmerson Lake. Office of Water Management, Indianapolis, IN.

13. Frey, D.G, 1955. Distributional ecology of the cisco in Indiana. Investigations of Indiana Lakes and Streams 4: 177-228. Indiana Univ. Dept. of Zoology.

14. Indiana University, 2002. Unpublished limnological data for Jimmerson Lake. School of Public and Environmental Affairs, Bloomington, IN.

15. Commonwealth Biomonitoring, 1995. Lake Enhancement Diagnostic Study for the Wawasee Area Watershed. Ind. Dept. of Natural Resources, Div. of Soil Conservation, Indianapolis, IN

16. Reckhow, K.H. and S.C. Chapra, 1983. Confirmation of water quality models. Ecological Modeling 20:113-133.

17. Cooke, G.D. and R.H. Kennedy, 1988. Water quality management techniques for reservoirs and tailwaters. Army Corps of Engineers Tech. Rep. E-87. Experiment Station, Vicksburg, MS.

18. Dresen, M.D. and R.M. Korth, 1994. Life on the edge...Owning waterfront property. Lake Management Program and Priority Watershed Program. Wisc. Dept. Nat. Res. University of Wisconsin Extension, Stevens Point, WI.

19. Kamber Engineering, 1990. Sediment and erosion control, an inventory of current practices. Prepared for U.S. EPA, Washington, D.C.

# Indiana Water Pollution Control Association, Inc.

Jimmerson Lake Association Meeting
Dec. 14, 2002

| Name | Address | |
|---|---|---|
| BOB STOPPENHAGEN | 4590 N. 300 W. | FREMONT |
| Wanda Gisna | " " | " |
| Don & Mary Miller | 295 J. L. Lane 425 | FREMONT |
| DAVID SWEIGART | 335 LN 275 JIMMERSON LK | ANGOLA, IN |
| BARBARA & JERRY CALKINS | 135 LN 275 JIMMERSON LK. | ANGOLA |
| Bill & Jeanette Cady | 135 Ln 425B Jimmerson LK | Fremont In 4673 |
| Jim MORING | 1040 Ln 340 Jimmerson Lk | FREMONT |
| Becki & Charlie Calhoun | 200 LN 340 Jimmerson LK | Fremont, IN |
| Phyllis & Jack Heinze | 205 Ln 101 Jimmerson LK | Angola IN |
| Roger Miller | 35 LN 101D Jimmerson LK | Angola, IN |
| JAMES & CHERYL HORSTMAN | 20 LN 150B Jimmerson | ANGOLA IN |
| JAMES & ARLENE CHRISTY | 560 LN 425 JIMMERSON | FREMONT IN |
| Oliver & Joanne Tribble | 520 LN 425 Jimmerson | " " |
| Herb & Shirley Rice | 500 LN 425 Jimmerson LK | " " |
| Tony & Denice High | 380 LN 425 Jimmerson LK | |
| Jerry & Mary E Miller | 240 LN 101 D Jimmerson LK | Angola IN |
| JOHN S. PETRY | 715 LN 275, JIMMERSON LK. | ANGOLA, IN. |
| TIM L. KNOBLAUCH | 355 LN 275 JIMMERSON LAKE, | ANGOLA, IN 46703 |
| Jim & Linda Miller | 4705 N 300W Jimmerson Lake | FREMONT IN 46737 |
| Gigi Hopkins | 280 LN 230 Jimmerson LK | ANGOLA IN 46703 |
| David M Boudia | 100 LN 230 Jimmerson LK | Angola IN 46703 |
| Judy E. Boudia | 100 LN 230 Jimmerson LK | Angola IN 46703 |
| Glen & Connie Bowen | 500 Ln 101 Jimmerson Lake | Angola, In 46703 |
| Max & Rovene High | 260 L D Jimmerson Lk. | |
| Tom Kreitner | 200 Ln 230 Jimmerson Lk, | Angola, IN 46703 |
| BILL HECKLEY | 80 LN 425A JIMMERSON LK | FREMONT IN 46737 |
| HOWARD A HARTMAN | 80 LN 101 D JIMMERSON LK | ANGOLA, IN 46703 |
| Jeff HARTMAN | 80 LN 101 D JIMMERSON LK, | ANGOLA, IN 46703 |

(260) 833-1435

# Model Results

Jimmerson Lake, Steuben County, Indiana
Model Assumptions - Includes Lake James in the model estimates

Lake Area, Mean Depth, Stream Runoff, and Evaporation
(Other Terms Calculated)

| | Units | Estimate |
|---|---|---|
| Lake Area | Km^2 | 5.2 |
| Mean Depth | meters | 11 |
| Detention Time | years | 0.89 |
| Areal Water Loading | m/yr | 12.30769 |
| Volume Water Load | 10^6m^3/yı | 64 |
| Lake Volume | 10^6m^3 | 57.2 |
| Stream Runoff* | m/yr | 0.8 |
| Watershed Area | Km^2 | 80 |
| Lake Evaporation | meters | 1.4 |
| Watershed/Lake Area | Ratio | 15.38462 |

Total Land Areas, Septic Tank Inputs, and Wastewater Treatment Plant

| Land Use | Area (hectares) |
|---|---|
| Agriculture1 | 6000 |
| Agriculture2 | 0 |
| Agriculture3 | 0 |
| Agriculture4 | 0 |
| Agriculture5 | 6000 |
| Forest | 1000 |
| Urban1 | 100 |
| Urban2 | 0 |
| Feedlots | 0 |
| Other1 | 1000 |
| Other2 | 0 |
| Other3 | 0 |

Septic Tanks & WWT

| | |
|---|---|
| #Capita-y | 3000 |
| P/pers-yr | 1.25 |
| N/pers-yr | 4.75 |
| P-soil ret | 0.7 |
| N-soil ret | 0.3 |
| MGD | 0 |
| P-conc | 2 |
| N-conc | 40 |

Predicted Lake Trophic State Variables

| | Present Situation | Elimination of Septic Tanks |
|---|---|---|
| Variable (units) | Expected | Expected |
| Total P-in (mg/l) | 0.042 | 0.025 |
| Total N-in (mg/l) | 0.96 | 0.81 |
| Total P (mg/l) | 0.030 | 0.018 |
| Total N (mg/l) | 0.43 | 0.39 |
| Chlor a (ug/l) | 5.30 | 4.00 |
| Secchi Depth (m) | 3.0 | 3.3 |
| TSI | 49 | 45 |

Reduction in Nutrients

| | |
|---|---|
| Phosphorus | 1125 kg/yr |
| Nitrogen | 9975 kg/yr |

## Present Situation - 3000 Septic Tank Users on Jimmerson Lake

| Variable (units) | 5th %ile | Expected |
|---|---|---|
| Total P-in (mg/l) | | 0.2136 |
| Total N-in (mg/l) | | 4.8428 |
| Total P (mg/l) | 0.0290 | 0.0401 |
| Total N (mg/l) | 0.5750 | 0.6003 |
| Chlor a (ug/l) | 5.7861 | 7.4652 |
| Secchi Depth (m) | | 3.2503 |
| Prob Hypo Anoxia | 0.0000 | |
| Prob BG Dominant | 0.0000 | |
| THMs | 0.0000 | 0.0000 |
| TSI | 50.2692 | 53.8444 |

## Changes Expected if 3000 Septic Tank Users are Removed from Jimmerson Lake

| Variable (units) | 5th %ile | Expected | 95th %ile |
|---|---|---|---|
| Total P-in (mg/l) | | 0.1250 | |
| Total N-in (mg/l) | | 4.0574 | |
| Total P (mg/l) | 0.0242 | 0.0334 | 0.0460 |
| Total N (mg/l) | 0.5618 | 0.5865 | 0.6123 |
| Chlor a (ug/l) | 5.0198 | 6.4653 | 8.3272 |
| Secchi Depth (m) | | 3.4688 | |
| Prob Hypo Anoxia | 0.0000 | | 0.0000 |
| Prob BG Dominant | 0.0000 | | 0.0000 |
| THMs | 0.0000 | 0.0000 | 0.0000 |
| TSI | 48.2757 | 51.8267 | 55.3777 |

Jimmerson Lake, including Lake James
Land Use and Septics Now

| Land Use Category | Area hectares | Septic Tanks | |
|---|---|---|---|
| Agriculture1 | 6000 | #Capita-yrs | 3000 |
| Agriculture2 | 0 | P/pers-yr | 1.25 |
| Agriculture3 | 0 | N/pers-yr | 4.75 |
| Agriculture4 | 0 | P-soil ret | 0.69 |
| Agriculture5 | 6000 | N-soil ret | 0.30 |
| Forest | 1000 | | |
| Urban1 | 100 | --------- | ----------- |
| Feedlots | 0 | MGD | 0 |
| Other1 | 1000 | P-conc | 2 |
| Other2 | 0 | N-conc | 40 |

Input Lake Area, Mean Depth,
Stream Runoff, and Evaporation

| Term | Units | Estimate |
|---|---|---|
| Lake Area | Km^2 | 5.2 |
| Mean Depth | meters | 11 |
| Detention Time | years | 4.50 |
| Areal Water Loading | m/yr | 2.4 |
| Volumetric WaterLoad | 10^6m^3/yr | 12.7 |
| Lake Volume | 10^6m^3 | 57.2 |
| Stream Runoff* | m/yr | 0.1 |
| Watershed Area | Km^2 | 127 |
| Lake Evaporation | meters | 1.4 |
| Watershed/Lake Area | Ratio | 24.4 |

Predicted Lake Trophic State Variables - Based on Hydrologic Variability
Present Situation

| Variable (units) | 5th %ile | Expected | 95th %ile |
|---|---|---|---|
| Total P-in (mg/l) | | 0.1280 | |
| Total N-in (mg/l) | | 1.1975 | |
| Total P (mg/l) | 0.0245 | 0.0337 | 0.0464 |
| Total N (mg/l) | 0.4206 | 0.4386 | 0.4573 |
| Chlor a (ug/l) | 5.0541 | 6.5101 | 8.3856 |
| Secchi Depth (m) | | 3.4583 | |
| Prob Hypo Anoxia | 0.0000 | | 0.0000 |
| Prob BG Dominant | 0.0000 | | 0.0000 |
| THMs | 0.0000 | 0.0000 | 0.0000 |
| TSI | 48.3714 | 51.9235 | 55.4757 |

Estimated effect of hydrologic variability on model prediction.

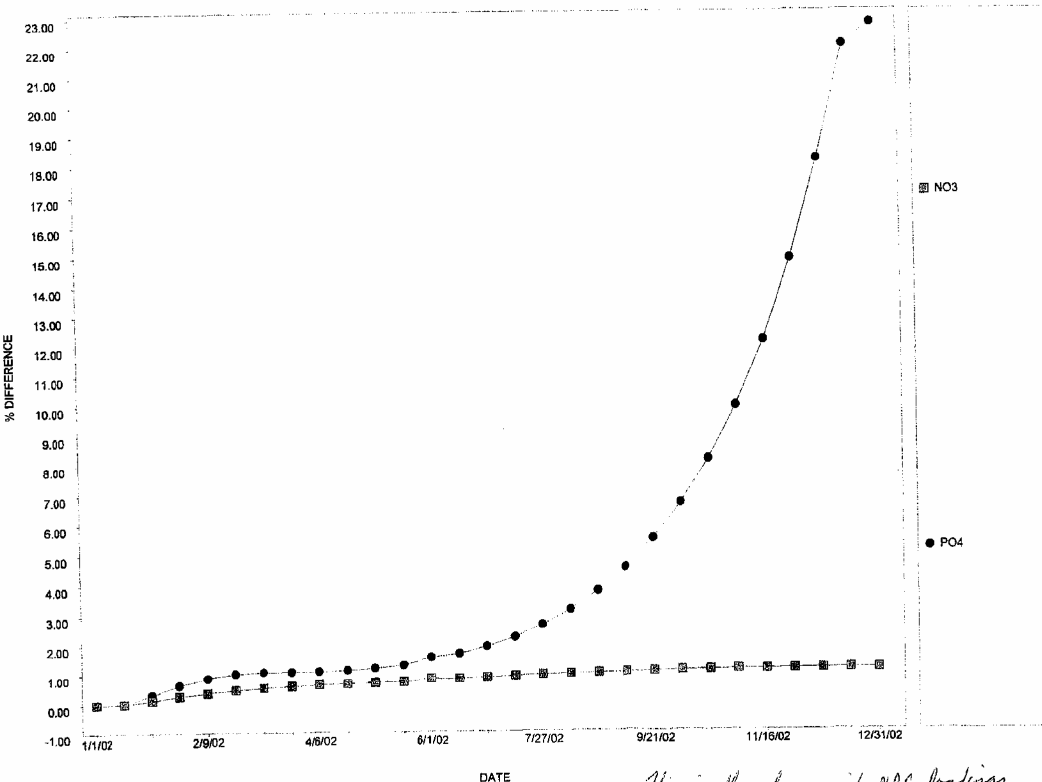
| Model | Std. Error |
|---|---|
| Phosphorus | 0.0828 |
| Nitrogen | 0.0108 |

Model results if ag converted to forest

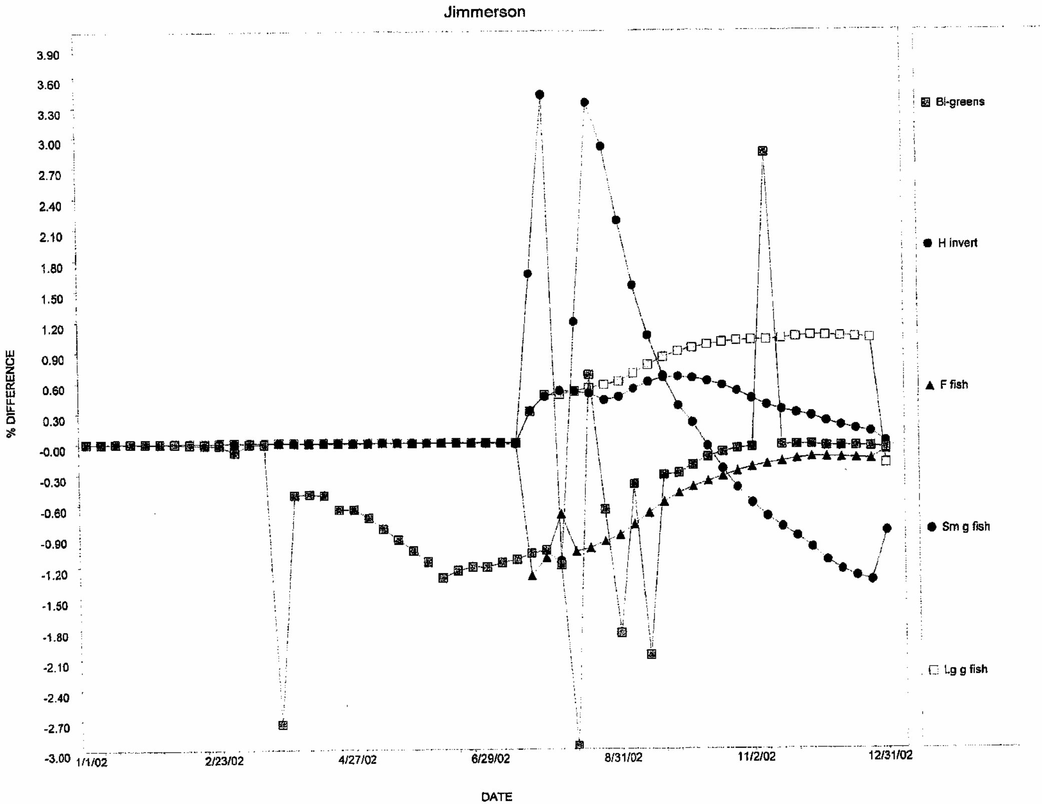
| State Variable Name | Init. Cond. | Units | Org. Tox. I.C. | Tox. Units |
|---|---|---|---|---|
| Ammonia | 0.05 | mg/L | | |
| Nitrate | 0.5 | mg/L | | |
| Phosphate | 0.05 | mg/L | | |
| Carbon dioxide | 0.7 | mg/L | | |
| Oxygen | 14 | mg/L | | |
| Labile sed. detritus | 0 | g/sq.m | | |
| Refrac. sed. detritus | 2400 | g/sq.m | | |
| L detr diss | 1.26 | mg/L | | |
| R detr diss | 5.04 | mg/L | | |
| L detr part | 0.14 | mg/L | | |
| R detr part | 0.56 | mg/L | | |
| Buried labile detritus | 2 | Kg/cu.m | | |
| Buried refrac. detritus | 2 | Kg/cu.m | | |
| Diatoms: [Diatoms] | 0.002 | mg/L | | |
| Blue-greens: [Cryptomonad] | 1E-6 | mg/L | | |
| Greens: [Greens] | 0.001 | mg/L | | |
| Detritivorous invertebrate: [Tubifex tub | 1 | mg/L | | |
| Herbivorous invertebrate: [Daphnia] | 0.2 | mg/L | | |
| Predatory invertebrate: [Rotifer, Brachi | 0.1 | mg/L | | |
| Bottom fish: [Catfish] | 0.1 | mg/L | | |
| Forage fish: [White Perch] | 0.2 | mg/L | | |
| Small game fish: [Largemouth Bass, YOY] | 0.1 | mg/L | | |
| Large game fish: [Largemouth Bass, Lg] | 2 | mg/L | | |

| State Variable Name | Init. Cond. | Units | Org. Tox. | I.C. | Tox. Units |
|---|---|---|---|---|---|
| Ammonia | 0.1 | mg/L | | | |
| Nitrate | 0.5 | mg/L | | | |
| Phosphate | 0.03 | mg/L | | | |
| Carbon dioxide | 0.7 | mg/L | | | |
| Oxygen | 12 | mg/L | | | |
| Labile sed. detritus | 100 | g/sq.m | | | |
| Refrac. sed. detritus | 100 | g/sq.m | | | |
| L detr diss | 0.18 | mg/L | | | |
| R detr diss | 0.72 | mg/L | | | |
| L detr part | 0.02 | mg/L | | | |
| R detr part | 0.08 | mg/L | | | |
| Buried labile detritus | 200 | Kg/cu.m | | | |
| Buried refrac. detritus | 200 | Kg/cu.m | | | |
| Diatoms: [Diatoms] | 0.002 | mg/L | | | |
| Blue-greens: [Cryptomonad] | 1E-6 | mg/L | | | |
| Greens: [Greens] | 0.001 | mg/L | | | |
| Detritivorous invertebrate: [Tubifex tub | 1 | mg/L | | | |
| Herbivorous invertebrate: [Daphnia] | 0.2 | mg/L | | | |
| Predatory invertebrate: [Rotifer, Brachi | 0.1 | mg/L | | | |
| Bottom fish: [Catfish] | 0.1 | mg/L | | | |
| Forage fish: [White Perch] | 0.2 | mg/L | | | |
| Small game fish: [Largemouth Bass, YOY] | 0.1 | mg/L | | | |
| Large game fish: [Largemouth Bass, Lg] | 2 | mg/L | | | |

Jimmerson Lake




*This is the change if NPS loadings*



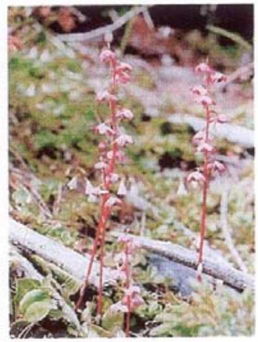
Jimmerson
3.90
3.60
3.30
3.00
2.70
2.40
2.10
1.80
1.50
1.20
0.90
0.60
0.30
-0.00
-0.30
-0.60
-0.90
-1.20
-1.50
-1.80
-2.10
-2.40
-2.70
-3.00
% DIFFERENCE
1/1/02
2/23/02
4/27/02
6/29/02
8/31/02
11/2/02
12/31/02
DATE
Bl-greens
H invert
F fish
Sm g fish
Lg g fish

# Some of Jimmerson Lake's Rare Species

bog rosemary

cottongrass


bladderwort



pink wintergreen

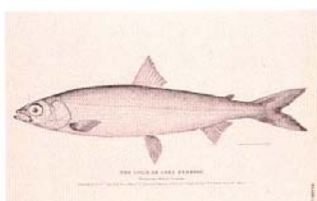
Canada warbler

Marsh wren

King rail

Black tern

Star-nosed mole



Cisco

Spotted turtle